



REUTERS EVENTS™

SMR & ADVANCED REACTOR 2024: CLOSING IN ON COMMERCIALIZATION



INTRODUCTION

May 2023 saw Microsoft signing a first-of-a-kind power-purchase agreement to buy zero-carbon electricity from a little-known energy provider, with supplies due to start around 2028.

Such agreements are commonplace as tech giants seek to decarbonize their supply chains, and the amount in question—50 megawatts (MW)—was trivial compared to the gigawatts (GW) of electricity that Microsoft consumes every year.

What made this deal newsworthy is that it involved procuring electricity from an energy source that does not yet exist.

Supplier Helion Energy is touting a technology called nuclear fusion, which could generate almost limitless amounts of energy—and is becoming tantalizingly close to commercial reality after decades of development and around \$5 billion in private funding.¹

The fact that fusion is not yet a proven technology has not dampened the tech sector's enthusiasm for its potential, with ChatGPT developer OpenAI also looking to tap Helion for "vast quantities" of energy, according to reports in June 2024.²



DEMAND FOR POWER

Like others in the tech sector, Microsoft and OpenAI—which has backing from the Redmond-based behemoth—face mounting power requirements as they roll out increasingly complex artificial intelligence (AI) systems.

The two firms are said to be planning to open a joint AI data center in 2028 that will consume a whopping 5 GW of power.

AI's immense energy needs are one of several factors driving interest not only in fusion but also another form of nuclear energy that has much greater chances of commercialization, according to speakers at Reuters Events' SMR & Advanced Reactor 2024 conference in May.

Unlike fusion, advanced and small modular reactor (SMR) technology is based on established nuclear fission processes and, while still subject to some commercial uncertainty, could be a much safer bet for AI-related clean energy demand, experts believe.

"Our goal is to deliver data center infrastructure in a way that provides the least environmental impact, and we believe advanced nuclear is helpful in achieving that," said Microsoft's director of nuclear development acceleration, Erin Henderson, at SMR & Advanced Reactor 2024.



MANY OPPORTUNITIES

Alasdair Harper, acting deputy director for advanced nuclear policy and delivery at the British government's Department for Energy Security & Net Zero, said providing power to data centers was one of several "fantastic opportunities and innovations in the advanced reactor space."

And Glenn Davis, director of Virginia Department of Energy, said his state was gearing up for an influx of new nuclear plants linked to data centers for AI. "In the next 15 years we are going to double our energy," he said.

Advanced nuclear technologies are designed to be smaller than conventional reactors and to have more components built under factory conditions, which supporters say could reduce the cost and deployment time for power plants without compromising safety or reliability.

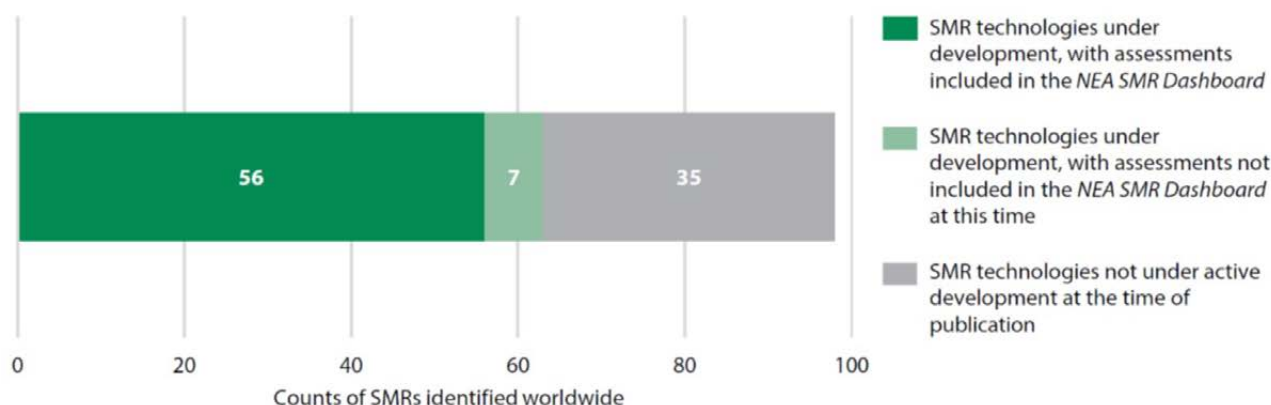
So far, the technologies have been slow to achieve commercialization because of regulatory hurdles and lack of standardization, with more than 80 designs for SMRs—advanced reactors of up to 300 MW—alone, according to the International Atomic Energy Agency.³



NUCLEAR PROLIFERATION: SMR DESIGNS ARE MULTIPLYING

SUPPLY CHAIN EFFICIENCIES WILL BE HARD TO FIND IN SUCH A DIVERSE MARKET

Source: The Nuclear Energy Agency Small Modular Reactor Dashboard, Second Edition (2024)



As of 2024, China and Russia were the only countries that could claim to have operational SMRs, and in Russia's case the claim is questionable since its sole SMR is powered by legacy icebreaker reactors rather than advanced nuclear technology.⁴

But recent months have provided important progress towards SMRs commercialization, with Korea Hydro & Nuclear Power (KHNP), ARC Clean Technology and Énergie NB Power signing a memorandum of understanding at SMR & Advanced Reactor 2024 to accelerate global deployment of the reactors.

The signing followed a January 2023 cooperation agreement between KHNP and the Emirates Nuclear Energy Corporation.⁵

Whang Joo-ho, KHNP's president and CEO, told audiences at SMR & Advanced Reactor 2024 that nuclear power could cover up to 25% of electricity supplies in the United Arab Emirates, saving 22 million tonnes of CO₂.

In South Korea, meanwhile, KHNP is aiming to combine innovative SMRs with renewable generation to power so-called SMR smart net-zero cities that Whang Joo-ho said could cut energy costs by 30% while contributing to economic growth and job creation.

And in February 2024, KHNP was named as one of two companies—alongside EDF of France—selected to provide binding bids for the construction of up to four new reactors at the Czech Republic's Dukovany nuclear power station.⁶

CLIMATE GOALS

The main motivation for this growth in interest is surging demand for clean energy to meet climate targets.

Although data centers represent one of the clearest examples of an industry striving to cut its carbon footprint, the need is increasing in almost every industrial sector—and compared to renewables such as wind and solar, advanced nuclear is attractive to industry players because it could supply electricity on demand.

In this respect, advanced nuclear is seen as a potential

successor to coal generation, which is being phased out in many western power markets.

In the United States, for example, 30% of existing coal plants are due to be retired by 2035, said Bryce Custer, energy services broker for commercial real estate service company Ohio River Corridor.

More than 300 current and retired coal plants could host advanced nuclear plants, he said, providing up to a 35% saving compared to building the facilities from scratch.



REPLACING FOSSIL

States considering a coal-to-nuclear transition include Arizona, Colorado, Kentucky, Maryland, Montana, North Carolina, Pennsylvania, Utah, West Virginia and Wisconsin, Custer said, with benefits to the Ohio River Corridor alone amounting to \$275 million a year in economic activity.

Such value is increasingly being reflected in government policies, according to experts at SMR & Advanced Reactor 2024.

Britain, for instance, is putting money into a generic design

assessment process as part of government policies to support nuclear, said Rick Springman, president of global clean energy opportunities at SMR developer Holtec.

The Labour Party, which is widely expected to wrest power from the Conservatives in a national election on July 4, has pledged to maintain Britain's support for nuclear power.⁷

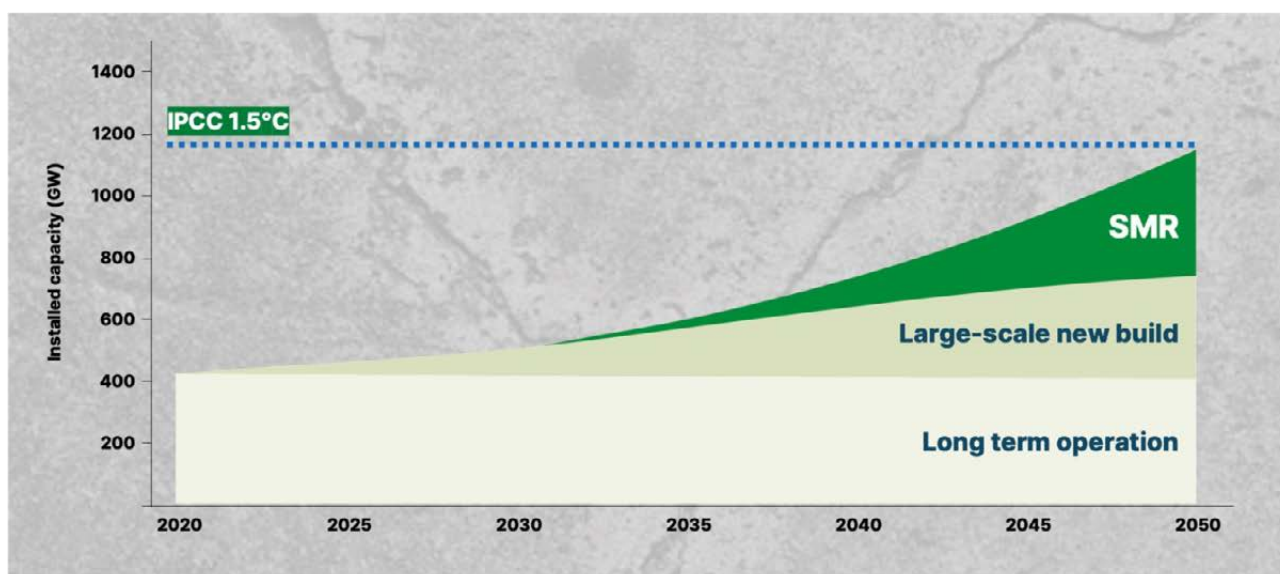
Demand for low-carbon, on-tap electricity is not only coming from a need to replace existing fossil fuel generation but also from new sources of demand, such as transportation.



SMRS ARE SEEN AS CRUCIAL TO HELPING MEET CLIMATE TARGETS

SMALL REACTORS ARE EXPECTED TO MAKE UP THE BULK OF NEW NUCLEAR BY MID-CENTURY

Source: The Nuclear Energy Agency Small Modular Reactor Dashboard, Second Edition (2024)



Omar Masud, deputy treasurer at state-owned Ontario Power Generation in Canada, said his utility was preparing to double its generation capacity as local municipalities and businesses electrified their vehicle fleets. Nuclear had to be part of the picture, he said.

Meanwhile Rob Edwards, managing director of investment bank Hamilton Clark Sustainable Capital, said nuclear could also be used to power electrolysis for the low-carbon production of hydrogen, a gas that is expected to replace fossil fuels in a range of industrial applications.

The problem right now was in trying to align the timelines for development of new nuclear capacity with hydrogen projects, he said.

One further source of revenue for new nuclear power could be for medical isotopes, the market for which was worth \$5.1 billion in 2022 and is expected to grow to \$11.4 billion by 2032.

Isotopes have one of the most severely compromised supply chains of any material in the world, said Paul Mann, chairman and CEO of ASP Isotopes, with 85% of production in Russia and the remainder in the Netherlands.

REPLACING FOSSIL FUELS

As well as being used for medical applications, isotopes are needed to produce advanced electronics and semiconductors and act as coolants in nuclear power stations. In future they could play a role in areas such as quantum computing and space exploration. "Isotope production is essential," Mann said.

Andrew Thiele, CEO of the Canadian Nuclear Isotope Council, said it was now possible to radiate isotopes without interrupting reactor power, leading to tremendous opportunities for targeting cancer treatment that could only be achieved if medical facilities around the world had resources that SMRs could provide.

Bill Walker, president and CEO of the Organization of Canadian Nuclear Industries, said using SMRs to produce medical isotopes could have a transformative effect. "We are seeing a groundswell of more excitement and enthusiasm," he said. "This will become a standalone industry."

Developers say they are prepared to meet this growing wave of demand. "The time is now," said Nicole Holmes, chief commercial officer at GE Hitachi Nuclear Energy. "We have the right partners and technology to react now—we are ready to go."

In the U.S., regulated utilities were well positioned to adopt SMR technology, with four or five already "close to ready," she said.



GETTING READY

Elsewhere, David Hanson, chief executive officer at lithium-fluoride low-enriched uranium reactor developer Flibe Energy, said his company was ready to accept orders for up to 8 GW of capacity for a design that could be delivered by 2040, providing electricity at a levelized cost of \$62 per megawatt-hour.

This cost is less than half of U.S. nuclear today, beats coal and is competitive with clean energies such as solar and onshore wind, based on data from investment bank Lazard.⁸ Yet even with figures such as these, Flibe Energy and other SMR developers could still face challenges in getting to market.

Principal among these is that without further rapid progress, SMRs risk being left behind by wind and solar. Today the cheapest wind and solar plants are already delivering electricity at less than half the cost of Flibe Energy's proposed reactor,⁹ and the costs will almost certainly have fallen further by 2040.

Nuclear advocates could point to the fact that SMRs will be dispatchable, overcoming the intermittency problems inherent in solar and wind power. But solar and onshore wind are already at \$60 or under even when tied to storage systems that mitigate the intermittency problem.



NEED FOR SPEED

Storage, too, is rapidly falling in cost, and towards the middle of the next decade it is expected that renewables could be tied to low-cost, low-carbon hydrogen for long-duration, gigawatt-scale power delivery. To stay in the game, advanced nuclear needs to scale up quickly.

Adding to concerns over advanced nuclear power's future are unresolved issues such as where to obtain the high-assay low-enriched uranium (HALEU) fuel that many designs (Flibe Energy excepted) will require. Today, the only commercial supply of HALEU comes from a Russian company, Tenex.¹⁰

The nuclear industry is aware of these problems and is working to solve them, with several speakers at SMR & Advanced Reactor 2024 showcasing innovations—from virtual reality tools to digital twins—that can speed up reactor design and improve operations.

Coupled with growing support in major markets such as Canada, South Korea and the U.S., this industrial momentum suggests SMRs and advanced nuclear technology could be on the cusp of breaking through to the mainstream and making a measurable difference to the energy transition. But it is a race against time.



REFERENCES

1. Timothy Gardner, Reuters, May 10, 2023: Microsoft signs power purchase deal with nuclear fusion company Helion. Available at <https://www.reuters.com/technology/microsoft-buy-power-nuclear-fusion-company-helion-2023-05-10/>.
2. Matthew Gooding, Data Centre Dynamics, June 6, 2024: OpenAI wants to buy 'vast quantities' of nuclear fusion energy from Helion - report. Available at <https://www.datacenterdynamics.com/en/news/openai-wants-to-buy-vast-quantities-of-nuclear-fusion-energy-from-helion-report/>.
3. International Atomic Energy Agency, 2024: Small modular reactors. Available at <https://www.iaea.org/topics/small-modular-reactors>.
4. Aaron Larson, Power Magazine, March 1, 2024: A Closer Look at Two Operational Small Modular Reactor Designs. Available at <https://www.powermag.com/a-closer-look-at-two-operational-small-modular-reactor-designs/>.
5. World Nuclear News, January 16, 2023: Korea and UAE agree to expand nuclear cooperation. Available at <https://world-nuclear-news.org/Articles/Korea-and-UAE-agree-to-expand-nuclear-cooperation>.
6. Kamen Kraev, NucNet, February 1, 2024: Czech Republic / Government Seeks Binding Tenders For Four Nuclear Reactors From EDF And KHNP. Available at <https://www.nucnet.org/news/government-seeks-binding-tenders-for-four-nuclear-reactors-from-edf-and-khnp-2-4-2024>.
7. The Labour Party, 2024: Switch on Great British Energy. Available at <https://labour.org.uk/missions/clean-energy/>.
8. Lazard, June 2024: Levelized Cost of Energy+. Available at <https://www.lazard.com/media/gjyffoqd/lazards-lcoeplus-june-2024.pdf>.
9. Ibid.
10. World Nuclear Association, December 13, 2023: High-Assay Low-Enriched Uranium (HALEU). Available at <https://world-nuclear.org/information-library/nuclear-fuel-cycle/conversion-enrichment-and-fabrication/high-assay-low-enriched-uranium-haleu>.